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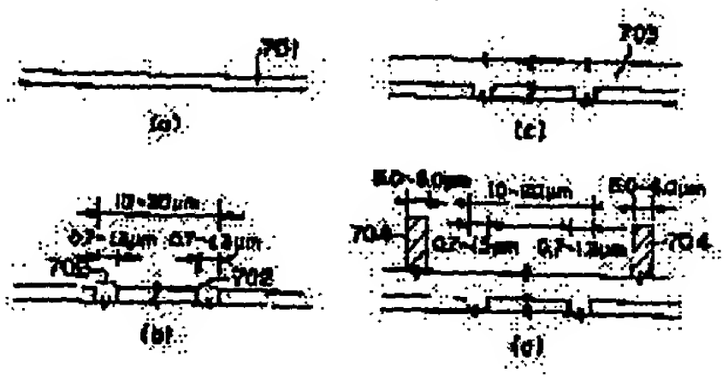
(54) **OVERLAY ACCURACY-MEASURING MARK AND MEASURING METHOD USING THE SAME**

(57)Abstract:
PROBLEM TO BE SOLVED: To perform highly accurate measurement and improve productivity, integration, etc., by forming a reference mark on a lower layer and using a resist pattern mark formed on an upper layer than the reference mark as a line pattern.
SOLUTION: A film of a material for forming a reference mark on a silicon substrate is formed. Namely, a film of polysilicon 701 is formed. Then, a pattern is formed by resist coating, exposure and development with a 0.7-1.3 μm slit pattern resist, and a reference mark 702 is formed by etching. Then, a material to be an interlayer film between the reference mark and the resist pattern mark is formed. Namely, a film of silicon dioxide 703 is formed. Then, a pattern mark (resist pattern mark) 704 is formed by resist coating, exposure and development.



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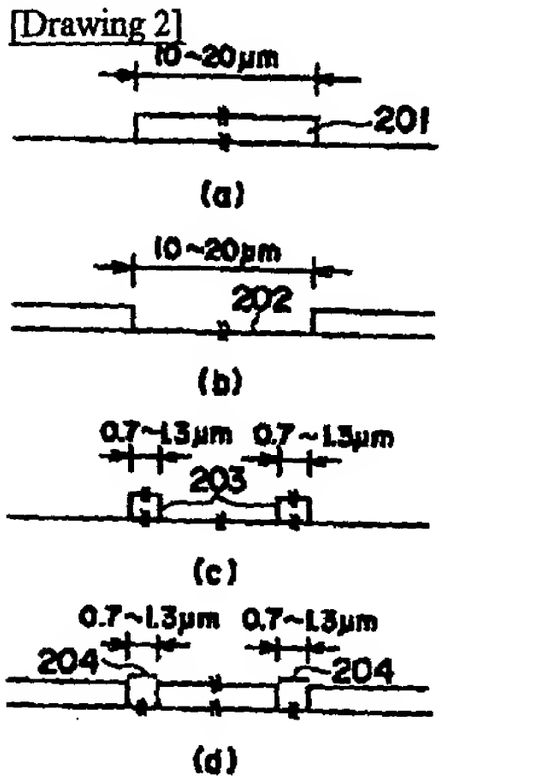
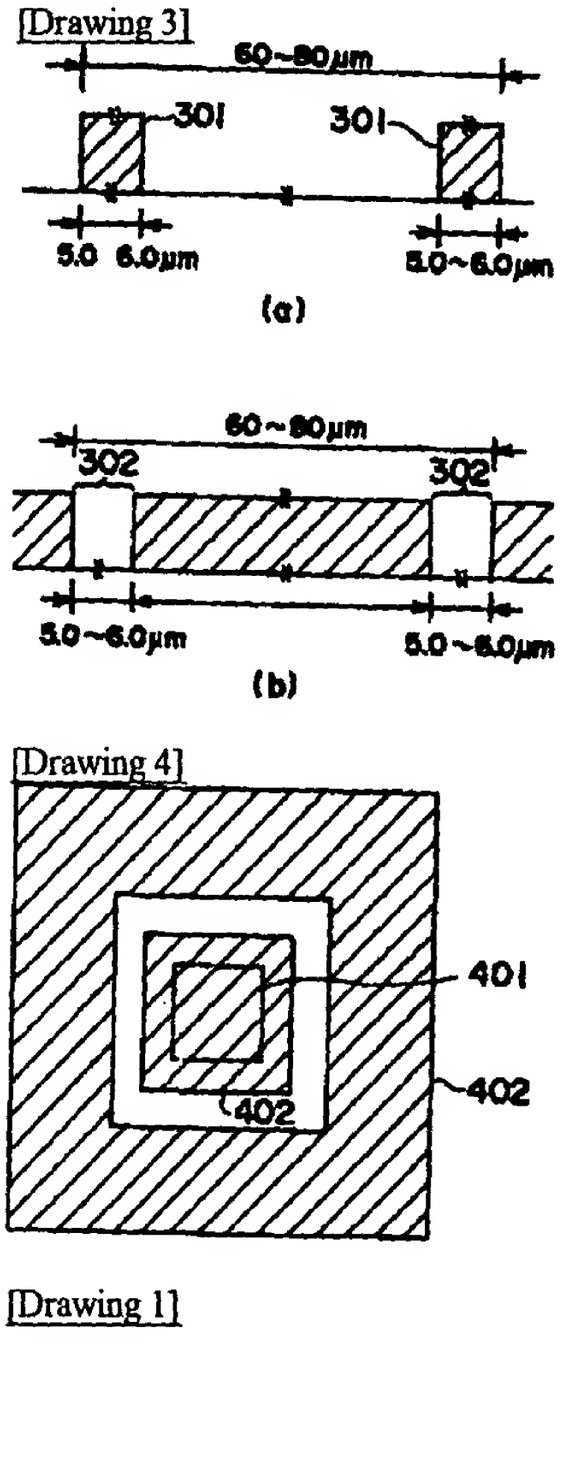
* NOTICES *

DRAWINGS

[Drawing 2]

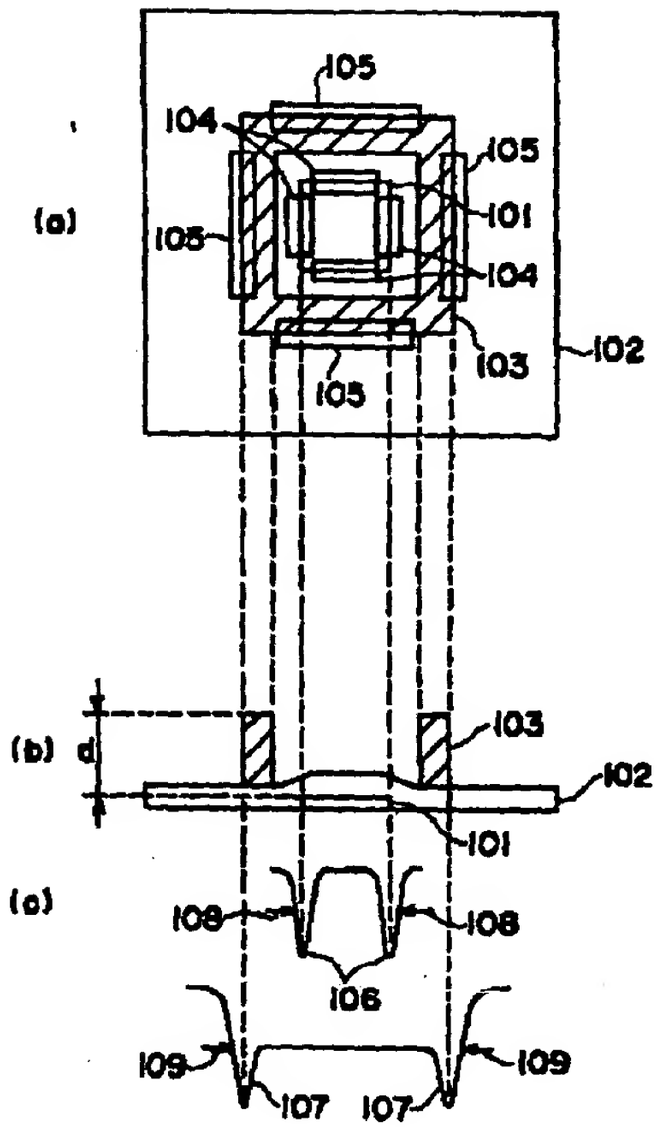


[Drawing 3]

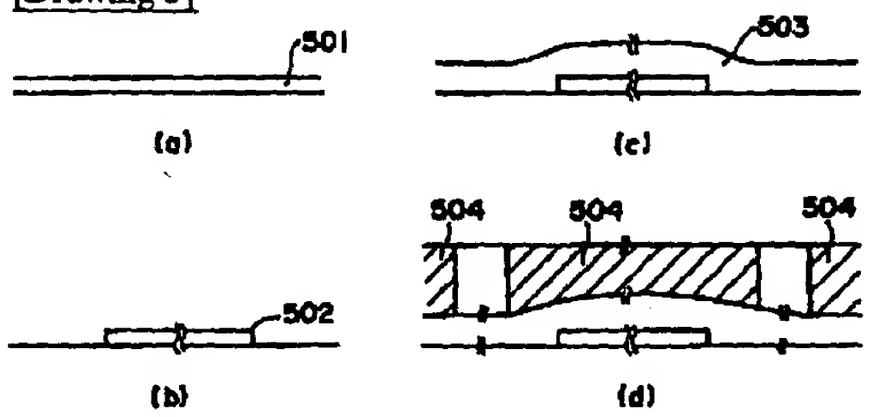


[Drawing 4]

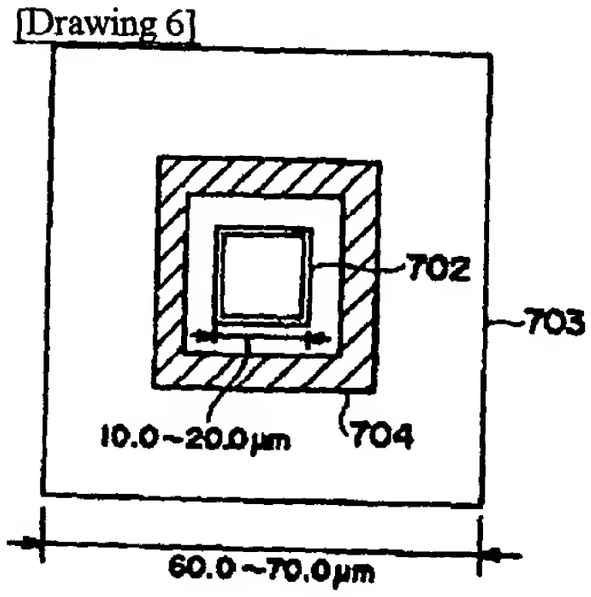
[Drawing 1]



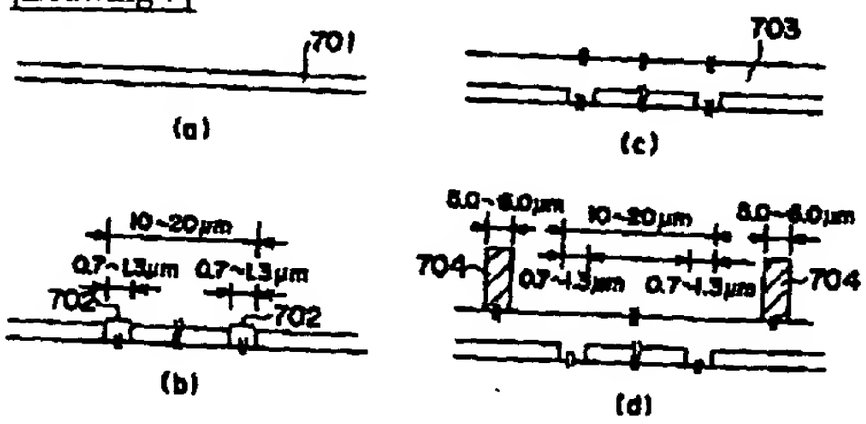
[Drawing 5]



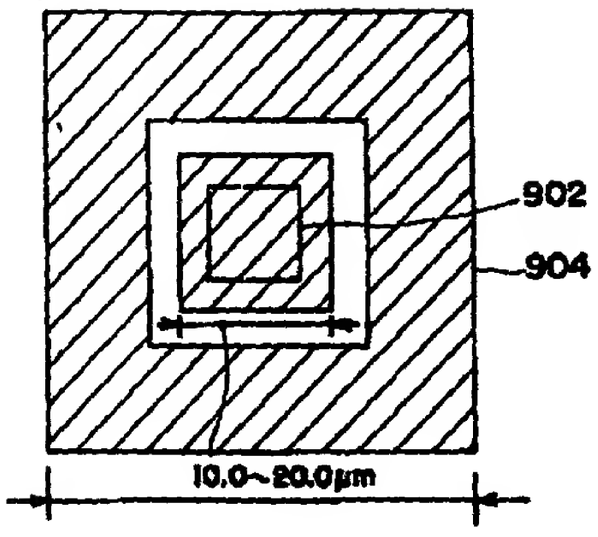
[Drawing 6]



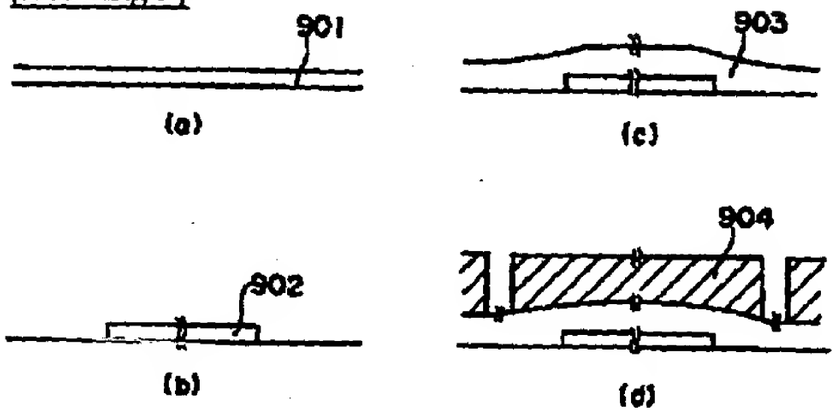
[Drawing 7]



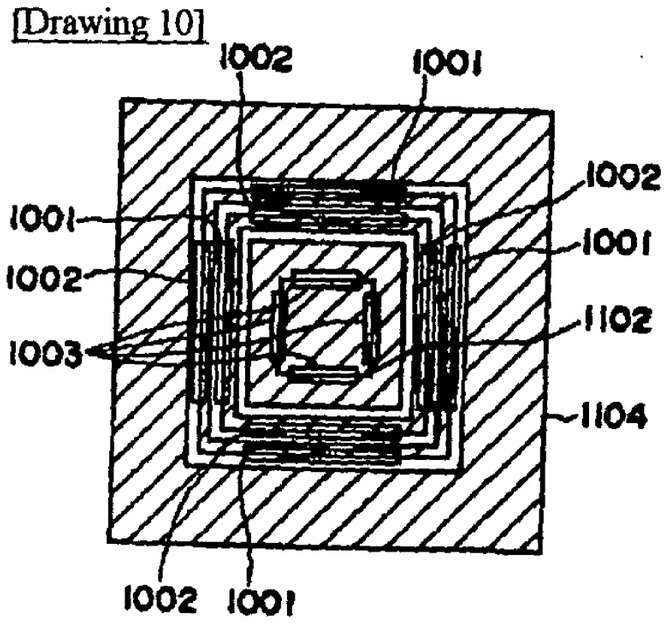
[Drawing 8]



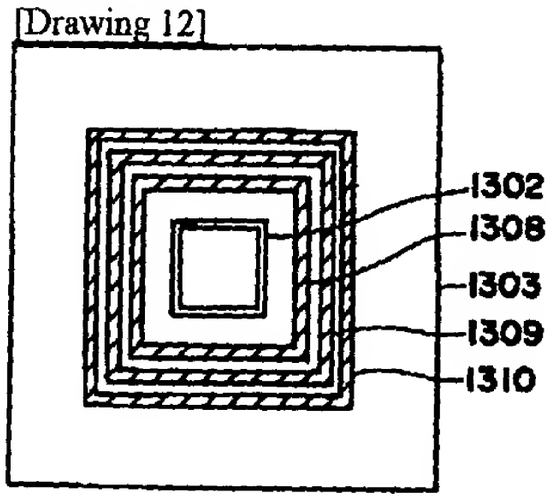
[Drawing 9]



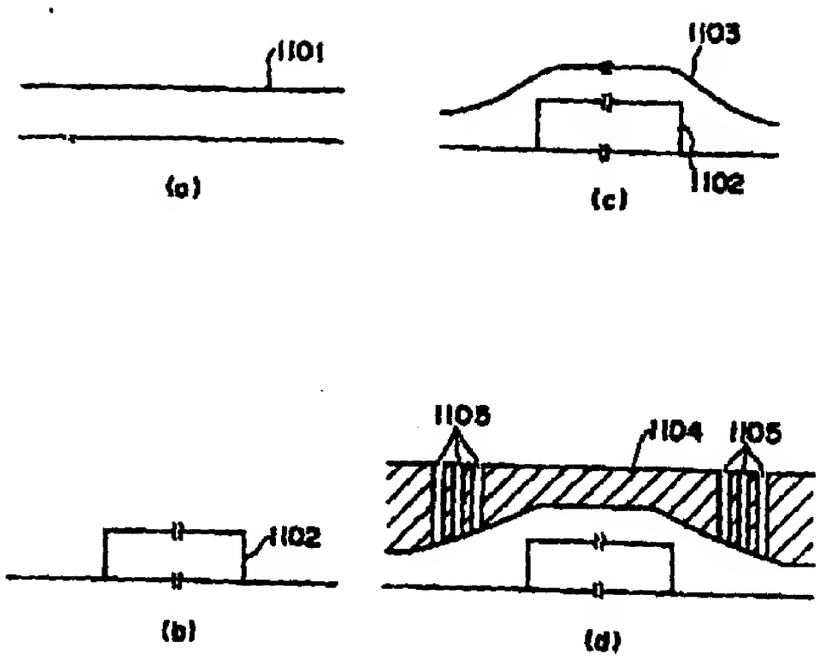
[Drawing 10]



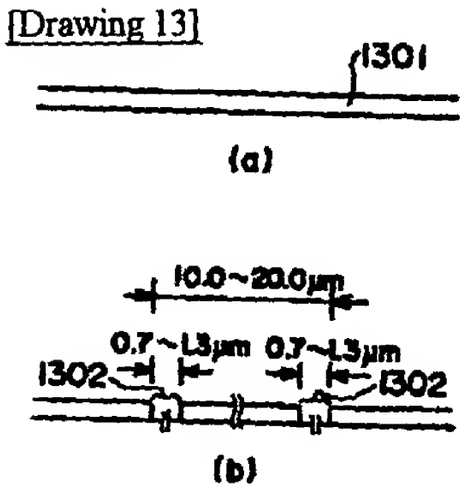
[Drawing 12]



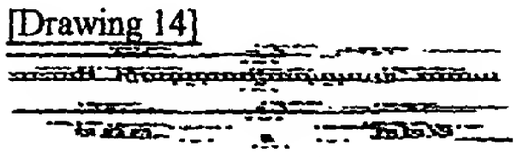
[Drawing 11]



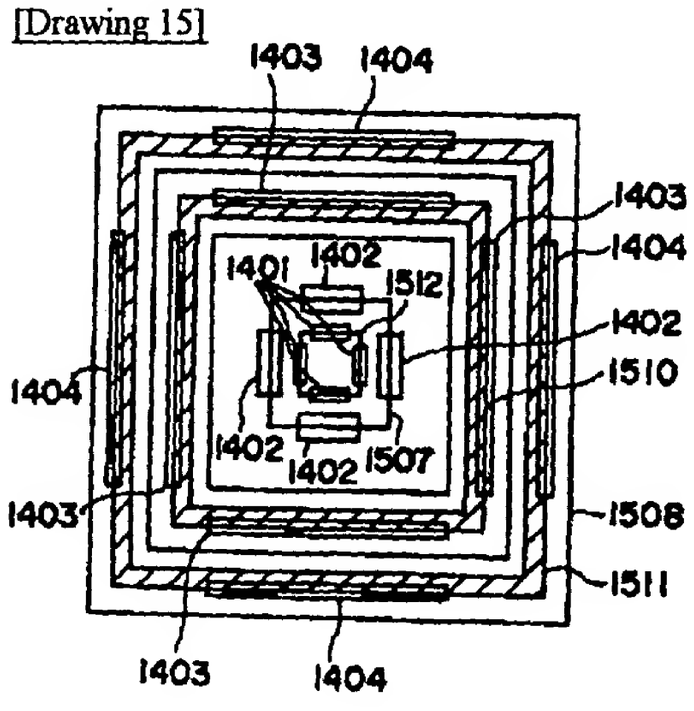
[Drawing 13]



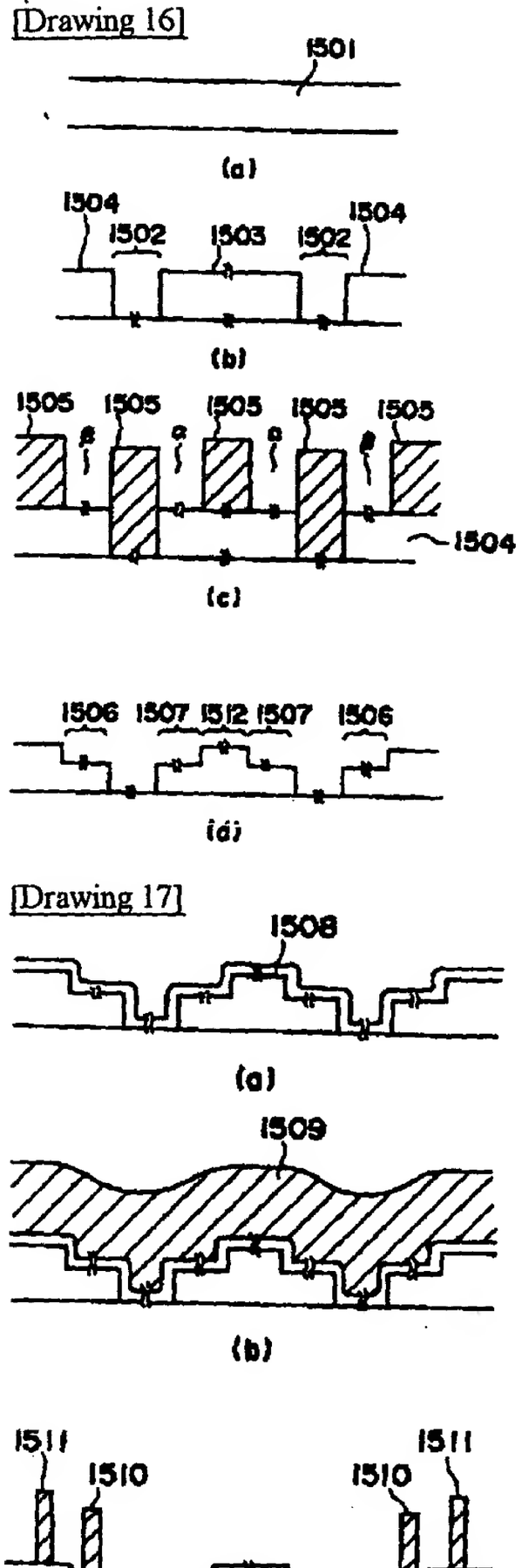
[Drawing 14]



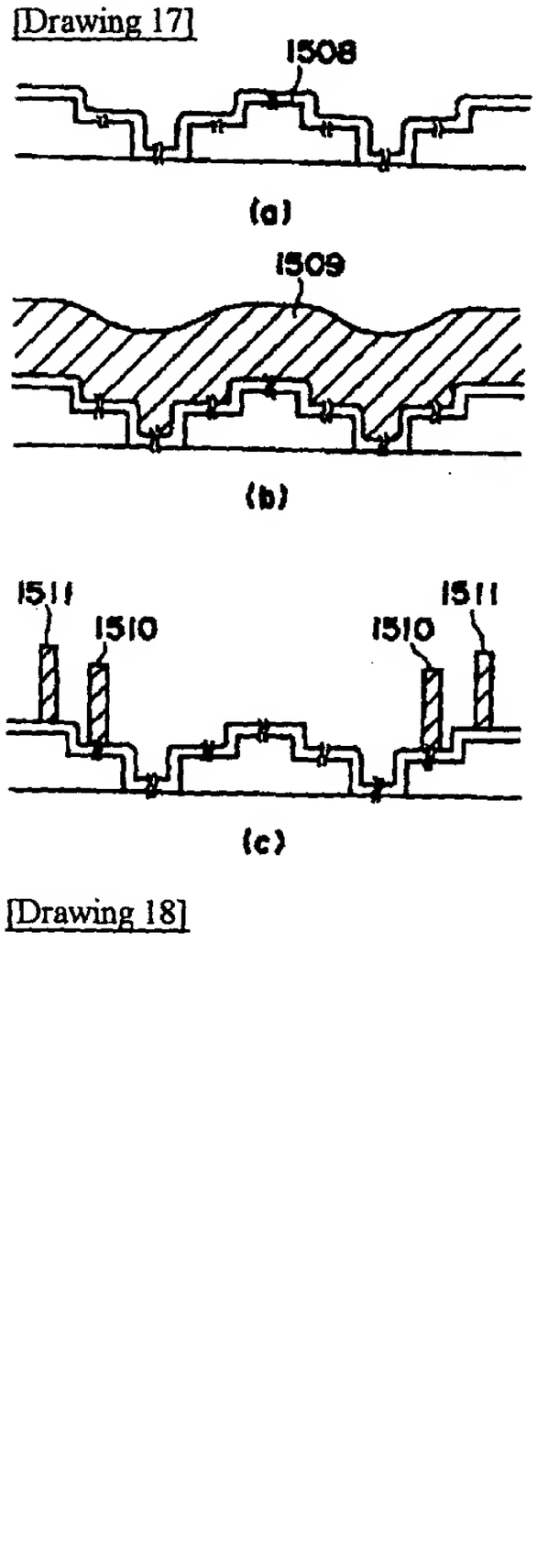
[Drawing 15]



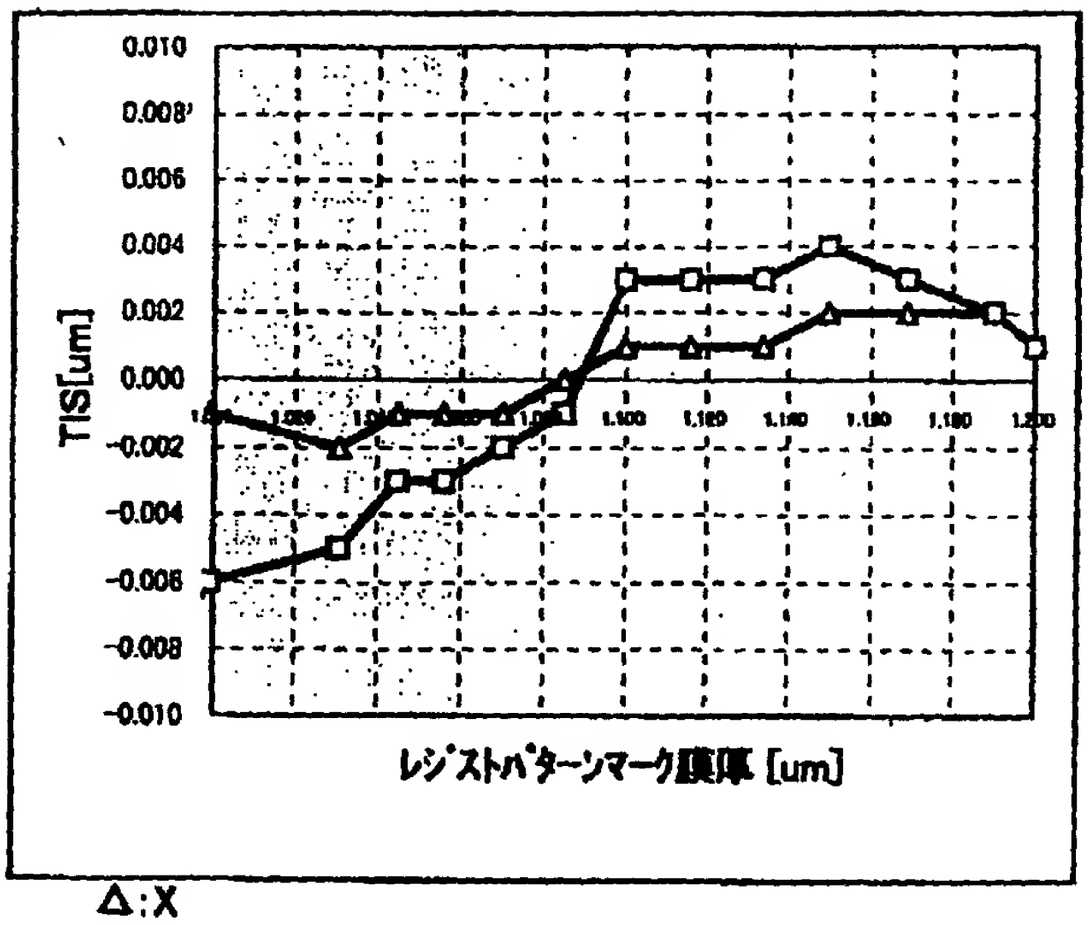
[Drawing 16]



[Drawing 17]

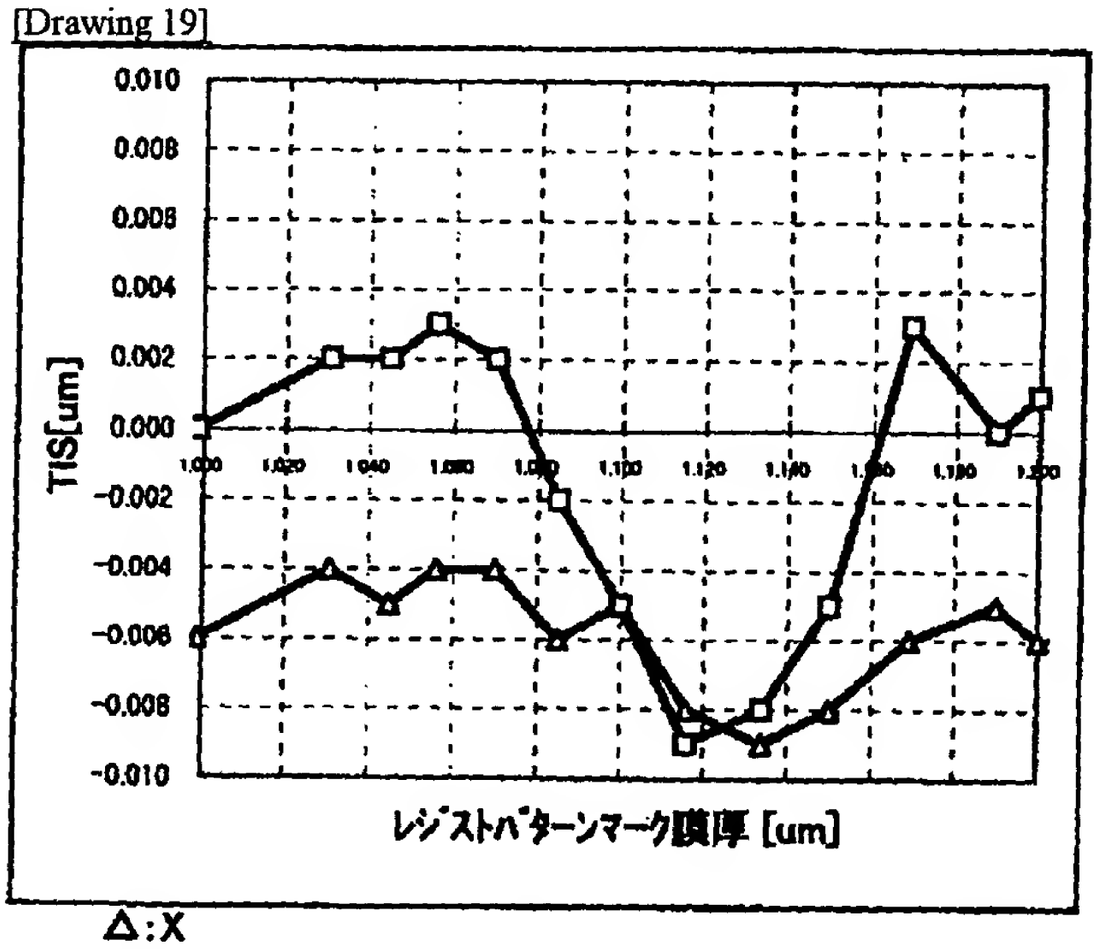


[Drawing 18]



△:X
□:Y
基準マーク:1.0μmスリット(図2(d))
レジストパターンマーク:5.5μmライン(図3. (a))

[Drawing 19]



△:X
□:Y
基準マーク:1.0μmスリット(図2(d))
レジストパターンマーク:5.5μmスリットライン(図3. (b))

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to effective technique, when a difference of elevation is between the reference mark especially used as a group, and a resist pattern mark about the technique of the measuring method using the mark for superposition precision measurement with the lower layer used in the case of exposure at the photo-lithography process for a semiconductor integrated circuit manufacture, and it.
[0002]
[Description of the Prior Art] The outline plan, the cross section, and wave signal-description view of the mark used for the superposition precision measurement in the conventional photo-lithography process at drawing 1 (a), (b), and (c) are shown, respectively.
[0003] the layer mesenteriolum which a reference mark and 102 become from a silicon dioxide in these drawings in 101, and 103 -- a resist pattern mark and 104 -- the wave signal of a resist pattern mark and 108 show the edge position of a reference mark, and, as for the edge recognition domain of a resist pattern mark, and 106, 109 shows the edge position of a resist pattern mark for the edge recognition domain of a reference mark, and 105, respectively, as for the wave signal of a reference mark, and 107
[0004] At a photo-lithography process, patterning of a circuit is performed through the process of an application of the resist to a wafer top, exposure, and development. In the case of exposure, it is required to pile up with the lower layer which is the pattern of the circuit at the time of reference-mark formation, and a sufficient precision.
[0005] As for this superposition, it is indispensable to expose using the correction value which measures the doubling gap with a lower layer by exposing without correction value first, and was obtained by the measurement. The technique of measuring the gap with the mark which formed the mark in the lower layer and was formed at the present process as the technique of measuring the gap with this lower layer is learned.
[0006] By this superposition precision measuring method, it asks by gap of the relative position with the resist pattern mark formed at the reference mark formed at the last process and the present process. Below, the combination of a reference mark and a resist pattern mark is piled up, and is described as the mark for precision measurement.
[0007] The light irradiated from the halogen lamp by the mark for superposition precision measurement on a wafer is processed to the wave signal of the intensity of light and darkness, and each mark edge is made to recognize in measurement by the superposition precision measurement machine.
[0008] Specifically, the domain of the edge used for measurement about each of a reference mark 101 and the resist pattern mark 103 is specified first. Each mark is processed by the wave signal of a light-and-darkness intensity, and serves as the wave signal 106 of a reference mark, and the wave signal 107 of a resist pattern mark from the domain 104 of the edge of a reference mark 101, and the domain 105 of the edge of the resist pattern mark 103. It can ask for the position of the edge of the orientation of X, and the orientation of Y by specifying the position of the edge of these waves.
[0009] A gap of the relative position of X and the orientation of Y can be found from a gap of the edge position of a reference mark 101 and the resist pattern mark 103.
[0010] By measurement by the superposition precision measurement machine, it is ideally desired with the value which measured the wafer at 0 degree used as criteria, and the value which rotated 180 degrees and was measured relatively [hoop direction / of a wafer] for the absolute value to be equal. However, it may differ from a factor which is described below. The value measured at this 0 degree and the value from which it is [at the time of 180 degrees rotating and measuring] different are called equipment reason error (Tool Induced Shift).
[0011] Next, the manufacture technique of the mark for superposition precision measurement is described. Drawing 2 (a) Four cross sections of a reference mark are shown in - (d). (a) is the 10-20micrometerx10-20micrometer square positive-type pattern 201. (b) is the 10-20micrometerx10-20micrometer square negative-mold pattern 202. (c) is 0.7 - 1.3 micrometer line type pattern 203. (d) is the 0.7-1.3-micrometer slit type pattern 204.
[0012] Two cross sections of a resist pattern mark are shown in drawing 3 (a) and (b). (a) is the 5.0-6.0-micrometer line type pattern 301. (b) is the 5.0-6.0-micrometer slit type pattern 302.
[0013] The plan of the mark for superposition precision measurement which combined the square positive-type pattern of drawing 2 (a) and the slit type pattern of drawing 3 (b) is shown in drawing 4 . In this drawing, 401 is a reference mark and 402 is a resist pattern mark.
[0014] Let the case where the pattern of drawing 2 (a) was used for the reference mark, and the pattern of drawing 3 (b) is used for a resist pattern mark, respectively be an example at the lithography process that that a transparent thick oxide film is formed on a reference mark in the following explanations the difference of elevation of a reference mark and a resist pattern mark is large.

[0015] The formation process of the mark for superposition precision measurement at the time of using the pattern of drawing 3 (b) for a reference mark at drawing 2 (a) and a resist pattern mark, respectively is explained one by one with reference to drawing 5 (a) - (d).
[0016] First, as shown in drawing 5 (a), the material which forms a reference mark on a substrate is formed. Here, contest 501 polysilicon is formed. Next, as shown in drawing 5 (b), a resist application, exposure, and development perform pattern formation of the reference mark by the resist, and a reference mark 502 is formed by etching.
[0017] Next, as shown in drawing 5 (c), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. For example, a silicon dioxide 503 is formed. Then, as shown in drawing 5 (d), resist application, exposure, and development are performed and the pattern (resist pattern mark) 504 by the resist is formed.
[0018]
[Problem(s) to be Solved by the Invention] About the combination of a reference mark and a resist pattern mark, when investigated zealously, the following thing was understood. The result is shown in Table 1 and the characteristic feature is described about the combination of a reference mark and each resist pattern mark.
[0019]
[Table 1]

基準マーク	レジストパターンマーク	TIS[nm]		測定再現性[nm]	
		X	Y	X	Y
正方形ポジ	レジストライン	6	4	4	3
	レジストスリット	2	3	4	4
正方形ネガ	レジストライン	5	6	4	5
	レジストスリット	8	3	4	3
ライン0.5μm	レジストライン	4	9	6	9
	レジストスリット	1	6	10	12
ライン1.0μm	レジストライン	6	1	4	6
	レジストスリット	1	9	8	4
スリット0.5μm	レジストライン	7	6	9	7
	レジストスリット	12	3	8	10
スリット1.0μm	レジストライン	1	1	4	3
	レジストスリット	7	1	4	4

表1. TIS調査結果

** When a reference mark is [a resist pattern mark] a slit pattern by the square negative pattern or the slit pattern, and when a reference mark is a line pattern, the difference of X and Y of the value of TIS becomes large.
** When 'reference mark is [a resist pattern mark] a slit pattern or a line pattern by the square positive pattern, the difference of X and Y of the value of TIS becomes small.
** When a reference mark is [a resist pattern mark] a line pattern by the square negative pattern or the slit pattern, the difference of X and Y of the value of TIS becomes small.
** In the case of the flute width of 0.5 micrometers, or line width of face, measurement reproducibility gets worse [a reference mark] irrespective of a slit or a line.
** The value of TIS changes with mark structures to 1.0nm - 12.0nm. The absolute value means that 1.0nm - 12.0nm differs with the value which, as for this, measured the wafer at 0 degree according to mark structure, and the value which rotated 180 degrees and was measured. When DRAM is taken for an example, in the case of 256Mb-DRAM (Dynamic Randam Access Memory) (0.25 0.20 micrometers -micro design rule), the trial calculation of the superposition gap allowed value with a substratum will be made with +-0.06micrometer, and about 20% will be taken by the measurement error according to mark structure. Since the superposition allowed value with a substratum becomes small, it is indispensable to reduce a measurement error as the degree of integration of a semiconductor device increases.
[0020] The measurement error which is the cause of the above characteristic feature is divided and stated to what is depended on an edge incorrect recognition, and the thing to depend on TIS.
[0021] About what is depended on an edge incorrect recognition, since one of edges serve as measurement by defocusing when the difference of elevation (d of drawing 1 (b)) of a mark arises to a reference mark and a resist pattern mark and they are made to recognize an edge in this focus, an incorrect recognition of an edge arises.
[0022] In the manufacturing process of a semiconductor integrated circuit, the laminating of a layer like the layer insulation layer 102 which consists of a silicon dioxide etc. is carried out between the reference mark and the resist pattern. Therefore, to a reference mark and a resist pattern mark, a mark difference of elevation may essentially arise. Moreover, even when transparent membranes, such as an oxide film thick on a reference mark, are formed, an incorrect recognition of an edge arises under the influence of an optical refraction.
[0023] About TIS, when the lens optical axis of a superposition precision measurement machine leans, by measurement (0 degree and 180 degrees), offset is added only to one side and it appears as measured value (0 degree and 180 degrees) of a difference.

[0024] It is appropriate for the cause described above to lap in composite and to think that TIS arises. This TIS can be decreased to some extent with enhancement and combination of the structure of the mark for superposition precision measurement.
[0025] Moreover, when thickness dependence of the resist pattern mark of TIS was investigated, as shown in drawing 18 and the drawing 19 , it turns out the thing which TIS changes with the thicknesss of a resist pattern mark, and that the inclination of change of TIS changes with structures of a resist pattern mark. Since a large thing is expected that it is guessed asily and dispersion in TIS within a wafer side also becomes large, the mark structure of TIS which becomes small is required for especially dispersion of a resist application thickness with the diameter wafer of the macrostomia with which this characteristic feature exceeds the diameter of 200mm.
[0026] Therefore, by elaborating a device on structure, a thickness, the combination, a measuring method of the mark [itself] for superposition precision measurement, etc., this invention enables highly precise measurement and makes it a subject to offer the technique of the measuring method using the mark for superposition precision measurement and it which can attain enhancement in a productivity, high integration, etc. by this.
[0027]
[Means for Solving the Problem] In order to solve the aforementioned subject, in this invention, it is a mark for superposition precision measurement with the lower layer used at the photo-lithography process for a semiconductor integrated circuit manufacture in the case of exposure, and the resist pattern mark was used as the line pattern including the reference mark formed in the lower layer, and the resist pattern mark formed in the upper field rather than the reference mark.
[0028] Here, a reference mark can also be considered as the configuration which are either the positive-type pattern of a flat-surface square, a negative-mold pattern and a slit pattern.
[0029] Moreover, also let resist pattern marks be two or more line patterns. In this case, it can also consider as the configuration which changed each thickness of two or more line patterns. Moreover, the thickness of each line pattern can also be changed by preparing a level difference in the front face of the substratum substrate which forms a line pattern.
[0030] Moreover, a reference mark is a positive-type pattern and it can also consider as the configuration which has a level difference in the front face. In this case, it is suitable to use a reference mark as the positive-type pattern of a flat-surface square, and to make one of them into the domain of 10-20 micrometers.
[0031] Moreover, a reference mark can be used as a slit pattern and the flute width can also be set to 0.6 micrometers or more.
[0032] Furthermore, about the line width of face of a resist pattern mark, it is suitable to consider as the domain of 5.0-6.0 micrometers.
[0033] The reference mark formed in the lower layer at the photo-lithography process for a semiconductor integrated circuit manufacture by this invention on the other hand, It faces measuring the superposition precision in the case of exposure using the resist pattern mark which consists of two or more line patterns formed in the upper field rather than the reference mark. Each edge position of two or more line patterns was measured, and the average of the measurement error included in each measured value was made into correction value, and it asked for the edge position of a resist pattern mark, and considered as the technique of computing the measured value of superposition precision.
[0034] In this case, each edge position of two or more line patterns is measured, and the line pattern with which the measurement error included in each measured value becomes the smallest can be chosen, and it can consider as the edge position of a resist pattern mark, and can pile up using the edge position, and the measured value of precision can also be computed.
[0035] moreover, the wafer top which is a substratum substrate about the mark for superposition precision measurement which consists of the combination of a reference mark and a resist pattern mark -- two or more -- preparing -- two or more point-of-measurement ****s within a wafer side -- the measurement error included in the measured value which was piled up and measured using the mark for precision measurement, respectively can choose the mark for parvus superposition precision measurement most, and can also compute measured value
[0036] Moreover, a reference mark and a resist pattern mark can choose the edge to which each edge of these reference marks and each edge ****** of a resist pattern mark, and a measurement error become the smallest including two or more edges, respectively, can be used as the edge of a reference mark, and the edge of a resist pattern mark, and can also compute the measured value of superposition precision.
[0037] Moreover, in this invention, it was a mark for superposition precision measurement with the lower layer used at the photo-lithography process for a semiconductor integrated circuit manufacture in the case of exposure, and including the reference mark formed in the lower layer, and the resist pattern mark formed in the upper field rather than the reference mark, the reference mark was used as the positive-type pattern of a flat-surface square, and the resist pattern mark was used as the slit pattern.
[0038] Here, also let resist pattern marks be two or more slit patterns. About two or more of these slit patterns, it is suitable to consider as the configuration from which each depth of flute is different.
[0039] Moreover, about the reference mark, it is suitable to make one of them into the domain of 10-20 micrometers. Moreover, it can also consider as the configuration which has a level difference on the surface of a reference mark. Moreover, the reference mark which consists of a positive-type pattern of the flat-surface square formed in the lower layer at the photo-lithography process for a semiconductor integrated circuit manufacture in this invention, It faces measuring the superposition precision in the case of exposure using the resist pattern mark which consists of a slit pattern formed in the upper field rather than the reference mark. Each edge position of two or more slit patterns was measured, and the average of the measurement error included in each measured value was made into correction value, and it asked for the edge position of a resist pattern mark, and considered as the technique of computing the measured value of superposition precision.
[0040] In this case, each edge position of two or more slit patterns is measured, and the slit pattern with which the

measurement error included in each measured value becomes the smallest can be chosen, and it can consider as the edge position of a resist pattern mark, and can pile up using the edge position, and the measured value of precision can also be computed.
[0041] moreover, the wafer top which is a substratum substrate about the mark for superposition precision measurement which consists of the combination of a reference mark and a resist pattern mark -- two or more -- preparing -- two or more point-of-measurement ****s within a wafer side -- the measurement error included in the measured value which was piled up and measured using the mark for precision measurement, respectively can choose the mark for parvus superposition precision measurement most, and can also compute measured value
[0042] Furthermore, a reference mark and a resist pattern mark can choose the edge to which each edge of these reference marks and each edge ****** of a resist pattern mark, and a measurement error become the smallest including two or more edges, respectively, can be used as the edge of a reference mark, and the edge of a resist pattern mark, and can also compute the measured value of superposition precision.
[0043]
[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained based on drawing.
[0044] (Gestalt 1 of operation) It lays on top of view 6 , and the process cross section for the mark formation for superposition precision measurement is shown for the plan of the mark for precision measurement in drawing 7 (a) - (d), respectively.
[0045] First, as shown in drawing 7 (a), the material which forms a reference mark on a silicon substrate is formed. Here, contest 701 polysilicon is formed. Next, as shown in this drawing (b), a resist application, exposure, and development perform pattern formation by the resist of 0.7 - 1.3 micrometer slit pattern, and a reference mark 702 is formed by etching.
[0046] Next, as shown in this drawing (c), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. Here, a silicon dioxide 703 is formed. Then, as shown in this drawing (d), the pattern mark (resist pattern mark) 704 by the resist is formed by a resist application, exposure, and development.
[0047] As the gestalt 1 of this operation showed, when [which used the reference mark 702 as the 0.7-1.3-micrometer slit, and made the resist pattern mark the 5.0-6.0-micrometer line] it piles up and the mark structure for precision measurement is used, the absolute value of TIS is small, and the difference of X and Y serves as the mark for parvus superposition precision measurement, and measurement reproducibility's improves. This combination is equivalent to the combination of ** stated in the card column of previous "subject."
[0048] In addition, since measurement reproducibility will get worse if it is 0.5 micrometers, 0.6 micrometers or more of 0.7 micrometers or more of the grounds for having made into the domain of 0.7-1.3 micrometers the flute width of the reference mark 702 which is a slit pattern be preferably required. Moreover, it is because it avoids that a reference mark 702 and the resist pattern mark 704 touch by being referred to as less than 1.3 micrometers and the wave signal (the wave signal 106, 107 references which are shown in drawing 1) of the light-and-darkness intensity by the measurement machine can be separated clearly.
[0049] Moreover, the ground for having carried out the resist pattern mark 704 which is a line pattern in line width of face of 5.0-6.0 micrometers is that the edge of one of the two of a resist pattern mark can be specified, and it can avoid an incorrect recognition of the wave signal of a light-and-darkness intensity when there were 5.0 micrometers or more and an edge recognition domain (edge recognition domain 105 reference shown in drawing 1) is specified. Since there is a possibility of touching a reference mark when it enlarges too much although it can also be referred to as 6.0 micrometers or more, it is not desirable.
[0050] (Gestalt 2 of operation) It lays on top of view 8 , and the process cross section for the mark formation for superposition precision measurement is shown for the plan of the mark for precision measurement in drawing 9 (a) - (d).
[0051] First, as shown in drawing 9 (a), the material which forms a reference mark on a silicon substrate is formed. Here, contest 901 polysilicon is formed. Next, as shown in this drawing (b), a resist application, exposure, and development perform pattern formation by the resist of a square positive-type pattern (it corresponds to drawing 2 (a)), and a reference mark 902 is formed by etching.
[0052] Next, as shown in this drawing (c), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. Here, a silicon dioxide 903 is formed. Then, as shown in this drawing (d), the pattern mark (resist pattern mark) 904 by the resist is formed by a resist application, exposure, and development.
[0053] In the gestalt 2 of this operation, when [which made the reference mark 902 the 10-20micrometerx10-20micrometer positive type, and used the resist pattern mark as the 5.0-6.0-micrometer slit] it piles up and the mark structure for precision measurement is used, the absolute value of TIS is small, and the difference of X and Y serves as the mark for parvus superposition precision measurement, and measurement reproducibility's improves. This combination is equivalent to the combination of **' stated in the card column of previous "subject."
[0054] In addition, the ground for having made into the domain of 10.0-20.0 micrometers one side of the reference mark which is a square positive pattern is that the accuracy of measurement will become bad if the four place specification (reference) of the edge domain of a reference mark can be carried out and this domain is narrow. However, since there is a possibility of touching a resist pattern mark beyond the need when it enlarges, less than 20.0 microns is desirable. Thereby, the wave signal (the wave signal 106, 107 references which are shown in drawing 1) of the light-and-darkness intensity by the measurement machine is clearly separable.
[0055] Moreover, the ground for having carried out the resist pattern mark 904 which is a slit turn in flute width of 5.0-6.0 micrometers is that the edge of one of the two of a resist pattern mark can be specified, and it can avoid an incorrect recognition of the wave signal of a light-and-darkness intensity when there were 5.0 micrometers or more and an edge recognition domain (edge recognition domain 105 reference shown in drawing 1) is specified. Since there is a possibility of touching a reference mark when it enlarges too much although it can also be referred to as 6.0 micrometers or more, it is not

desirable.
[0056] (Gestalt 3 of operation) It lays on top of view 10 , and the process cross section for the mark formation for superposition precision measurement is shown for the plan of a precision measurement mark in drawing 11 (a) - (d).
[0057] First, as shown in drawing 10 (a), the material which forms a reference mark on a silicon substrate is formed. Here, contest 1101 polysilicon is formed. Next, as shown in this drawing (b), a resist application, exposure, and development perform pattern formation by the resist of a 10-20micrometerx10-20micrometer square positive-type pattern (it corresponds to drawing 2 (a)), and a reference mark 1102 is formed by etching.
[0058] Next, as shown in this drawing (c), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. Here, a silicon dioxide 1103 is formed. Then, as shown in this drawing (d), the pattern mark (resist pattern mark which has two or more slits 1105) 1104 by the resist is formed by a resist application, exposure, and development.
[0059] Measurement using this mark is performed by the following technique.
(1) Technique using the average of the edge of a plurality [recognition / edge / of a resist pattern mark].
[0060] By this technique, two or more edge recognition domains are specified about a resist pattern mark (1001 of drawing 10 , 1002). At the time of measurement, it is asked for an edge position from an edge recognition domain, respectively. In quest of the mean place of these edge positions, it considers as the edge of a resist pattern mark, and when computing measured value, it uses.
(2) How to choose from two or more edges the edge of TIS which becomes small.
[0061] By this technique, measurement (0 degree and 180 degrees) is beforehand performed to the edge recognition domain 1003 of a reference mark using the edge recognition domains 1001 and 1002 of a resist pattern mark. It asks for the edge of the resist pattern mark to which TIS becomes the smallest from the result, and measures using the edge.
(3) How to choose respectively independently the optimum edge of TIS which becomes small, and to ask for an edge position about two or more point of measurement in a wafer.
[0062] By this technique, when measuring in two or more positions within a wafer side, it measures in a wafer side using the mark for superposition precision measurement of TIS which becomes small, respectively. Measurement (0 degree and 180 degrees) is beforehand performed to the edge recognition domain 1003 of a reference mark using the edge recognition domains 1001 and 1002 of a resist pattern mark. In quest of the smallest edge of TIS in a wafer side, it measures by each from the result.
[0063] In the gestalt 3 of this operation, as the card column of previous "subject" described, TIS changes with the thicknesss of a resist pattern mark. Then, in order to reduce the change of TIS by dispersion in the thickness of a resist pattern mark, the resist pattern mark which combined two or more slits from which a thickness is different is used. The effect is described about each measuring method.
[0064] First, in the technique of (1), it is effective in the measured value which reduced the influence of change (dispersion) of a resist thickness according to the equalization effect of two or more edge positions of a resist pattern mark being obtained. That is, the equalization effect of an edge position is making into the value of TIS of a resist pattern mark what was averaged using each value of TIS calculated about each edge, and means that the measured value to which rather than reduced [which used two or more edges] the influence of thickness change is obtained using one edge. Thereby, enhancement in the accuracy of measurement can be aimed at.
[0065] Next, in the technique of (2), it is selection of the edge of a resist pattern mark, and it is using the edge of TIS which becomes small, and is effective in the measured value which reduced TIS being obtained. That is, according to this technique, since a thickness dependency also means a small thing inevitably, the parvus edge of TIS can reduce the influence of the part and thickness change, and can aim at enhancement in the accuracy of measurement.
[0066] Next, in the technique of (3), it is enabling it to choose respectively independently the optimum edge of TIS which becomes small, and is effective in the measured value which reduced the influence of dispersion within the wafer side of a resist thickness, and reduced TIS being obtained. That is, among the marks for superposition precision measurement of the masses prepared respectively independently in two or more [in a wafer side], by the thing of TIS for which a parvus thing is chosen most, selection of a measuring object mark required because of the enhancement in the accuracy of measurement can be extended throughout the inside of a wafer side, and can be performed. Thereby, the influence of dispersion within the wafer side of a resist thickness can be reduced, and enhancement in the accuracy of measurement can be aimed at. This combination is equivalent to the combination of **' stated in the card column of previous "subject."
[0067] (Gestalt 4 of operation) It lays on top of view 12 , and the process cross section for the mark formation for superposition precision measurement is shown for the plan of the mark for precision measurement in drawing 13 (a) - (d) and drawing 14 (a) - (d).
[0068] First, as shown in drawing 13 (a), the material which forms a reference mark on a silicon substrate is formed. Here, contest 1301 polysilicon is formed. Next, as shown in this drawing (b), a resist application, exposure, and development perform pattern formation by the resist of a 0.7-1.3-micrometer slit pattern (it corresponds to drawing 2 (d)), and a reference mark 1302 is formed by etching.
[0069] Next, as shown in this drawing (c), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. Here, a silicon dioxide 1303 is formed. Next, as shown in this drawing (d), in order to prepare a level in the difference of elevation of a reference mark and a resist pattern mark, the pattern 1304 by the resist which contains 8.0-10.0-micrometer slit pattern 1304a by a resist application, exposure, and development is formed, as shown in drawing 14 (a) after an appropriate time, the layer mesenteriolum 1303 is etched (etching 1) and 1st **** 1305 is formed.
[0070] Similarly, as shown in drawing 14 (b), the pattern 1306 by the resist which contains 8.0-10.0-micrometer slit pattern 1306a by a resist application, exposure, and development is formed, as shown in this drawing (c) after an appropriate time, the layer mesenteriolum 1303 is etched (etching 2) and 2nd **** 1307 is formed. here -- etching 1 and the etching 2 --

etching time -- differing -- the [the height from the front face of the layer mesenteriolum 1303 to the base of 1st **** 1305, and] -- a difference of elevation is made to arise in the height to the base of 2 **** 1307
[0071] Then, as shown in this drawing (d), the pattern marks (resist pattern mark which forms two or more lines) 1308, 1309, and 1310 by the resist are formed by a resist application, exposure, and development.
[0072] Using this mark, as stated above (gestalt 3 of operation), it measures by the following technique.
(1) Technique using the average of the edge of a plurality [recognition / edge / of a resist pattern mark].
(2) How to choose from two or more edges the edge of TIS which becomes small.
(3) How to choose respectively independently the optimum edge of TIS which becomes small, and to ask for an edge position about two or more point of measurement in a wafer.
[0073] Also in the gestalt 4 of this operation, as the card column of previous "subject" described, TIS changes with the thicknesss of a resist pattern mark. Therefore, in order to measure by the resist pattern mark of TIS which becomes small, a resist thickness is changed by preparing a level difference in a substratum. The effect is described about each measuring method. First, in the technique of (1), it is effective in the measured value which reduced the influence of thickness change of a resist pattern mark according to the equalization effect of the edge position of a resist pattern mark being obtained.
[0074] Next, in the technique of (2), it is selection of the edge of a resist pattern mark, and it is using the edge of TIS which becomes small, and is effective in the measured value which reduced TIS being obtained.
[0075] Next, in the technique of (3), it is enabling it to choose respectively independently the optimum edge of TIS which becomes small, and is effective in the measured value which reduced the influence of dispersion within the wafer side of a resist thickness, and reduced TIS being obtained.
[0076] Especially in the gestalt 4 of this operation, it is enabled to change a thickness positively. Therefore, the domain of thickness change can be extended also in the technique of what ** of the above (1), (2), and (3). Since the measurement based on the thickness influence which changed in the large domain by this is attained, there are the part and an effect that the smaller value of TIS can be calculated positively. This combination is equivalent to the combination of **' stated in the card column of previous "subject."
[0077] (Gestalt 5 of operation) It lays on top of view 15 , and the process cross section for the mark formation for superposition precision measurement is shown for the plan of the mark for precision measurement in drawing 16 (a) - (d) and drawing 17 (a) - (c).
[0078] First, as shown in drawing 16 (a), the material which forms a reference mark on a silicon substrate is formed. Here, contest 1501 polysilicon is formed. Next, as shown in this drawing (b), by a resist application, exposure, and development, pattern formation by the resist of a 8.0-10.0-micrometer slit pattern is performed, and the slit 1502 formed by etching between the positive-type reference mark 1503 of a flat-surface square and the polysilicon contest layer 1504 of the periphery is formed.
[0079] Next, as shown in this drawing (c), in order to prepare the difference of elevation of the height orientation in a reference mark and a resist pattern mark, the pattern 1505 by the resist for forming 3.0-7.0-micrometer slit alpha on a reference mark 1503, and forming 7.0-10.0-micrometer slit beta on the polysilicon contest layer 1504 by a resist application, exposure, and development, is formed simultaneously. As shown in this drawing (d) after an appropriate time, a reference mark 1503 and the polysilicon contest layer 1504 are etched, formation of 1st **** 1506 and 2nd **** 1507 is performed, and it leaves surface section 1512 fraction.
[0080] Next, as shown in drawing 17 (a), the material used as the layer mesenteriolum between a reference mark and a resist pattern mark is formed. Here, a silicon dioxide 1508 is formed. Then, by an application of a resist 1509, exposure, and development, as shown in this drawing (b), as shown in this drawing (c), pattern formation by the resist is performed and the line type resist patterns 1510 and 1511 are formed.
[0081] Using this mark, as stated above (gestalt 3 of operation), it measures by the following technique.
(1) Technique using the average of the edge of a plurality [recognition / edge / of a reference mark].
(2) How to choose from two or more edges of a reference mark the edge (1401 or 1402 of drawing 15) of TIS which becomes small.
(3) How to choose respectively independently the optimum edge of TIS which becomes small, and to ask for an edge position about two or more point of measurement in a wafer.
(4) How to choose the combination of the edge of TIS which becomes small about the combination of a reference mark and a resist pattern mark, and to ask for an edge position. this technique -- the edge recognition domains 1401 and 1402 of a reference mark -- about each, the combination of the edge of a reference mark which serves as the minimum of TIS about the edge recognition domains 1403 and 1404 of a resist pattern mark, and the edge of a resist pattern mark is chosen, and it measures using the mark for superposition precision measurement
[0082] Also in the gestalt 5 of this operation, as the card column of previous "subject" described, TIS changes with the thicknesss of a resist pattern mark. Therefore, in order to measure by the resist thickness of TIS which becomes small, in addition to the technique of changing the thickness of a resist pattern mark, a difference of elevation is prepared also in a reference mark by preparing a level difference in a substratum. By doing so, the height of the resist pattern mark to a reference mark changes relatively.
[0083] The effect is described about each measuring method.
[0084] First, in the technique of (1), it is effective in the measured value which reduced the influence of change (dispersion) of a resist thickness according to the equalization effect of the edge position of a reference mark being obtained.
[0085] Next, in the technique of (2), it is selection of the edge of a reference mark, and it is using the edge of TIS which becomes small, and is effective in the measured value which reduced TIS being obtained.
[0086] Next, in the technique of (3), it is selection of the edge of a resist pattern mark, and it is enabling it to choose respectively independently the optimum edge of TIS which becomes small, and is effective in the measured value which

reduced the influence of dispersion within the wafer side of a resist thickness, and reduced TIS being obtained.

[0087] In the gestalt 5 of this operation, since the difference of elevation of the resist pattern mark to a reference mark can also be changed positively in addition to enabling it to change the thickness of a resist pattern mark positively, the domain of thickness change of the appearance of a resist pattern mark can be enlarged further. The measurement based on the influence of the thickness which changed in the large domain by this is attained, and there are the part and an effect that the still small value of TIS can be calculated positively. In addition, since it is considering as the gestalt which prepares a level difference also in a reference mark and has two or more so-called edges, combination of the optimum thing of two or more edges of a reference mark and the optimum thing of two or more edges of a resist pattern mark is made, and enhancement in the part and the accuracy of measurement can be aimed at. This combination is equivalent to the combination of **' stated in the card column of previous "subject."

[0088]

[Effect of the Invention] According to this invention, by elaborating a device on structure, a thickness, the combination, a measuring method of the mark for superposition precision measurement, etc., highly precise measurement can be enabled and the technique of the measuring method using the mark for superposition precision measurement and it which can attain enhancement in a productivity, high integration, etc. by this can be offered.

[Translation done.]